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logical result which the nascent activities would have if they were completed. While Mach did not carry through the empirical method consistently, he wrought a change in our philosophical attitude or temper of mind which secures for him a permanent place in the record of human progress.

Neo-Realistic Logic and Science.—A. W. MOORE.

Expounders of the analytic logic of neo-realism hold two very different views of its relation to science, viz., (*a*) that analytic logic is not a methodology, but is a special science, with its own special interest, subject-matter, and method; and (*b*) that it affects a long-needed reform in scientific logic by excluding the "psychological," "subjective" process of knowledge and by furnishing science with its long-sought "simple" elements. Its difficulties may be summarized as follows: (1) It accepts from epistemological logic the "subjective" character of the *act* of knowing; (2) in excluding from logic the act of knowing it breaks with science, as is seen particularly in its view of hypotheses; (3) it is unable to make a workable distinction between truth and error; and (4) the simple elements which it proposes to furnish to science are the hypostatized acts of knowing which were previously rejected and which are neither simple nor of value for science.

The Co-Functions of Meaning.—A. MITCHELL.

Read by title.

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REVIEWS AND ABSTRACTS OF LITERATURE

The Limitations of Science. LOUIS TRENCHARD MORE. New York: Henry Holt and Company, 1915. Pp. 268.

The main contentions of this vigorously written and acute criticism of current scientific methods and theories are. (1) That physical science has no ontological value, and that its proper business is to describe in symbolic terms the properties common to the members composing a class of sense phenomena. (2) That therefore the truly fruitful method of science is the abstractive method, which proceeds in accordance with the above description of the genuine business of science. (3) That the hypothetical method, so much in vogue to-day among the "energeticists," the "etherists," and the "electronists," which method consists in assuming the existence of a fictitious class of objects which can not be perceived by the senses (why does Professor More call these objects "phenomena" when, by definition, they can not be perceived by the senses?), but to which there are nevertheless attributed qualities similar to those of sense phenomena, is a method fruitful of confusion between the fictions of imagination and objective realities, fruitful of manifold contradictions, and unfruitful in the promotion of scientific discoveries. (4) That the problem as to the ultimate nature of things should be left to the metaphysicians.

I am not at all clear (and I suspect that the author is not clear) as to what Professor More means by metaphysics. On the first page he seems to regard it as the subjective method of investigating objective data: "That is, things are as we think them to be." In another place (p. 188) he speaks of the unfortunate results which have accrued to men of science, when, "succumbing to the temptation to discover the hidden causes of phenomena, they have created a sort of fictitious world in which the laws of objective or physical phenomena are inextricably confounded with the deductions of subjective psychology." Thus science becomes metaphysical, and at the same time pretends to supplant metaphysics. In still another place, he seems not quite certain about the boundary line between physics and metaphysics, not quite so confident that he can tell the physicist and the metaphysician how each is to keep in his own bailiwick. Still he holds that we can say in a general way that the domain of physics is concerned with the discovery of phenomena and the formulation of natural laws based on postulates which are determined by experience and generally accepted as true; the causes of phenomena and the discussions of the postulates of science lie in the province of the metaphysician (pp. 113–114). For example, the shape of the electron is not a physical but a metaphysical problem, since it is incapable of verification by experience. In other words anything incapable of experimental verification is a proper subject for metaphysics and "subjective psychology." In short, I suppose that metaphysics is concerned chiefly, or perhaps only, with those problems concerning which nobody can really find out anything. In the language of a contemporary humorist it deals only with what is "behind the beyond." It follows, too, that psychology is not a science, unless, indeed, Professor More would admit that, besides "subjective" psychology, there is also an objective psychology. But then he defines the objective as the physical. Therefore the only "objective" psychology would be physical psychology, a bad name for physics, chemistry, and biology. It follows also that, when one wants to be a metaphysician, all one has to do is sit down with his eyes shut (if that helps him the better to extrude from his mental field the troublesome "objective" world) and to imagine, according to fancy and in disregard of the possibility of verification, all sorts of entities dancing and careering behind the veil of experience. I take it that Professor More would say that this sort of thing is quite harmless provided the genuine scientist does not indulge in it and mix its fantastic results with his science into a mass whose ingredients are indistinguishable by the layman and usually by the scientist himself. Professor More's grievance against most of the notable scientists of the present time seems to be that they are given to compounding just such mixtures. I suspect that he regards the professional metaphysician as a harmless but useless wool-gatherer. It seems truly unfortunate that great physicists can not curb their metaphysical impulses.

Professor More complains with much justice that physical theorists have not been schooled in philosophy sufficiently to know when they are off or on their own beat. I think that the complaint applies to the author. His conception of the scope and method of metaphysics is both antiquated and naïve. Those of us who still regard metaphysics as a serious pursuit for some intelligent beings look upon its business as that of investigating the fundamental postulates and general results of the special sciences and of arriving at the maximum of coherent and synthetic interpretation of reality, *as found in experience.* Metaphysics has to do with the most general and fundamental characteristics of the objective or existent world. Logically anything which exists is an object and a proper subject of scientific, that is to say of systematic, inquiry. Professor More's treatise is on the epistemology of physics. Now, if one is going into this field, and a very important field it is, one should formulate clear conceptions of the meaning of "object," "objective," "subject," "subjective," "reality," "existence," etc. These terms are notoriously dubious and equivocal in common usage. Psychology has to do with psychical subjects or minds, but it does not follow that psychology consists of a lot of subjectivistic imaginings or guesses. Physics has to do with physical or spatial objects, but it does not follow that all its so-called phenomena are epistemologically or really objective. Professor More seems to forget that every physicist is a human being with sense-organs, brain, and even mind, a good deal like the rest of us. Was it not the Blondlot rays that leading French physicists saw, but that Professor Wood and others could not see at all? One might suppose from Mr. More's argumentation that speculating and guessing never really led to fruitful observations and discoveries.

I would not have my criticism of Professor More's naïveté in philosophy, and especially in epistemology and methodology, detract from the impression of the instructiveness to the student of the philosophy of science of his critical exposition of "The Metaphysical Tendencies of Modern Physics," "Descartes and his Influence on Recent Science," "The Scientific Method," and "The Classical and the New Mechanics." These chapters abound in interesting matter. He keeps steadily in mind his general theses, and, by wealth of illustration and clearness and vigor of statement, he makes out a strong case on the inconsistencies and speculative difficulties of recent physical theory. He has no difficulty in showing up the inconsistencies and weaknesses in recent conceptions of the ether, the atom, the electron, matter, and space. The hypothetical method of the new mechanics, he points out, makes mechanical mass or intertia a phenomenon of energy, and, indeed, of electricity. The latter in turn becomes a property of the ether, and the ether, in turn, evaporates into empty space or becomes a pure vacuum. The electromagnetic theory of ether, in its latest developments, implies that light has the power of changing a vacuum into a substance. In fact ether is hardly intelligible except as a mathematical symbol. Professor More thinks that the time is rapidly approaching when all scientific discussions of the nature of the ether will be considered futile. "If bodies are forms of electricity how can they move through an electrical medium without disturbing it?" "We are driven (by the Larmor and Lorentz theories) to the supposition that the electron is a space modification of a universal medium and that, in some way, neither electron nor ether is a material substance, but a kind of transcendental entity called electricity." "If motion increases mass (as the new mechanics assumes) then mass becomes infinite when the velocity of light is reached." "They (Larmor and Lorentz) have really only substituted an electrical atom which will not explain matter for a material atom which would not explain electricity." "The Fitzgerald-Lorentz hypothesis, made to explain the Michelson-Morley experiment, namely, that the dimensions of bodies were so changed by their motion as to neutralize the effect of the earth's motion on the phenomena of light, would mean that every body when it attained a speed equal to the velocity of light, would flatten out to a disc of no thickness at all." These are specimens of his criticism. Professor More stoutly maintains that "we have no conception of matter without energy or of energy without matter." Ostwald's question as to which we feel first when a stick strikes us, the stick or the energy, he says, is as wise as the question which comes first, the egg or the chicken. His criticism of Einstein's relativity theory, which does away with ether and postulates space as a vaccum, the velocity of light as an absolute constant, and time as simply synchronism not the experience of succession, seems to me, as a layman, particularly telling. He says that Einstein's definition of time gives him the feeling that, if he could make clocks go slower his life would become longer. (Einstein's theory is, of course, a beautiful illustration of the confusion between time conceived in terms of a recurrent or rhythmic spatial motion and actually experienced time as succession or duration.) The whole discussion of the attempt of the electronist to make mechanical mass and gravitational attraction phenomena of electric charge deserves careful weighing. As well, also, the discussion of the game of hide and seek between matter, energy, space, and ether in present-day physical speculation.

In short, Professor More has no difficulty in showing that these concepts are used by physicists in very fluctuating senses, and that, if they are to be taken as representing real entities, then physical theory becomes involved in a mass of inconsistencies.

Such is the danger which besets the wholesale employment of the hypothetical method. Therefore, says Professor More, let us abandon it to the professional metaphysicians. The danger is real, and the despised and rejected metaphysician will not be able to repress an unholy glee at seeing the votaries of exact science floundering in metaphysical morasses. But I respectfully suggest that the remedy proposed is too drastic. I doubt if the impulse to form hypotheses and make guesses as to the real "go" of things can be expunged in this fashion. I suggest that a good dose of philosophy might enable the patient to eliminate the toxins due to overindulgence of the "metaphysical" appetite. Is it not your second or third rate physicist who regards the atoms, electrons, and ethers, as indubitably real existences? If a first-rate physicist does so, I submit that it is because his philosophy is so very naif. Is it not the case that the minds most fruitful in scientific discovery, such as Darwin's, Faraday's, Kelvin's, and Thomson's, are always fertile in hypothesis? Are not hypotheses for them policies and programmes, incitements and pointings to further investigations? If this be true, then there must be some psychological and logical connection between imaginative construction and discovery. If physicists were to resign all attempts to picture or conceive the inner go or hang of physical processes, and severely restricted themselves to methods of abstraction would we not get a race of pedestrian recorders and measurers, piling up observations unenlightened by any far-reaching and unifying synthesis? I remember that Simon Newcomb once said that this sort of uninterpretive amassing of facts was the bane of American science. Consider the extraordinary fertility of Darwin's and Faraday's minds! Consider the stimulating effects of the molecular theory of gases, the wave theory of light and electricity, the theory of natural selection, and of Thomson's and Rutherford's speculations on radioactivity! It is surely a most significant coincidence that the pioneers in investigation are always fertile in hypotheses. What is a hypothesis, after all, but an intellectual scheme or picture for correlating facts and impelling a man to look for new facts?

Professor More's argument has not convinced me of the valuelessness or the terrible dangers of the hypothetical method. It is the expression of a native impulse of the human mind, the impulse to seek to see deeper into the interrelationships of things, to trace analogies and find correlations, which is at work in different guises in the scientist, the philosopher, and the poet. Rightly employed, it leads to the discovery of new facts and new relations between facts. To crush it out would be to reduce science to a process of routine registration of routine perceptions.

Is it, after all, so scandalous a thing that Kelvin, Faraday, Thomson, Lorentz, *et al.*, while they proclaim themselves to be devotees of purely objective science, indulge rather freely in metaphysical flights so bold that your philosopher, browbeaten by the contemptuous severity of the scientific positivist, would never have dared to essay them? Professor More's ideal of science seems to be the same as Auguste Comte's, and he, of course, banished metaphysics—and smuggled it in again as the Worship of Humanity and the Eternal Feminine. When the philosopher sees that the speculative physicists are leading the field, he takes heart of grace and ventures to suggest that he does not wish to deal in transcendental moonshine, but only to carry out farther (as far as may be) the work of synthetic correlation of the main features and directions of this empirical and moving old world. Perhaps physics is not so sternly objectivistic and philosophy so riotously subjectivistic as the blatant scientific positivist has been shouting.

I ought to mention, in conclusion, that Professor More has a sharp and telling criticism on Sir Oliver Lodge's vagaries and on the grossly exaggerated pretensions of so-called scientific methods of handling the social problems of eugenics, the latter under the caption "Science as Arbiter of Ethics." The whole book is thoroughly worth while.

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